1. Features

- Firmware for 10 open collector outputs module
- 3 control instructions (on, off, toggle)
- 3 blocking instructions
- 10 timers (1 for each output) for instruction execution delay 1s-24h
- Allows defining up to 128 CAN messages which can indirectly control the module
- Settable output power up state
- Uptime counter
- Health check monitor
- Transmit (42 messages) and receive (42 messages) FIFO buffers

2. Compatibility

- Firmware for UNIV 3.9.0.x module
- Firmware can be uploaded into processor with bootloader version 3.1 or compatible.

3. Firmware version

UNIV 3 . 9 . 0 . 0

- 0 – firmware version
- 0 – application version
- 9 – application (open collector outputs)
- 3 – processor version
- UNIV – universal processor

4. Communication Frames (messages)

4.1. Open collector output message

The module sends one message to the bus for each channel as soon as the status of one of the outputs changes. The following table shows the meaning of individual bytes in the frame.

Table 1. OC output frame (0x309)

Frame type	Flags				Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x309	3	2	1	0	Node Nr	Group Nr	0xFF	0xFF	CHANNEL	STATUS	0xFF	INSTR1	0xFF	TIMER

0x309 – universal module frame, OC output

- 3 - - not used flag, read as "0"
- 2 - - not used flag, read as "0"
- 1 - - not used flag, read as "0"
- 0 RE - response flag, flag is equal "1" if node was requested. If flag is equal „0" it means that status of output has just changed.

- Node Nr - message sender node number
- Group Nr - message sender group number
- CHANNEL - output channel
- STATUS - actual status of outputs 0x00 – output off, 0xFF – output on
- INSTR1 - instruction that is waiting for execution, or 0xFF if none instruction
- TIMER - delay value of waiting instruction, or 0x00 if none waiting

4.2. Status request

Status of module can be checked by sending from computer STATUS REQUEST frame (0x109) (Table 2).

Table 2. STATUS REQUEST frame (0x109).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x109	0x0	COMP ID1	COMP ID2	0xXX	0xXX	Node Nr	Group Nr	0xXX	0xXX	0xXX	0xXX

0x1090 – STATUS REQUEST frame

COMP ID1 - computer identifier (must be unique on the network)
COMP ID2 - computer identifier (must be unique on the network)

Node Nr - node number of requested module

Group Nr - group number of requested module

0xXX - inessential data

As response the module will send OC output frames. The meaning of bytes is the same as in Table 1.

Table 3. Response to STATUS REQUEST

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x01	STATUS	0xFF	INSTR1	0xFF	TIMER1
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x02	STATUS	0xFF	INSTR1	0xFF	TIMER2
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x03	STATUS	0xFF	INSTR1	0xFF	TIMER3
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x04	STATUS	0xFF	INSTR1	0xFF	TIMER4
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x05	STATUS	0xFF	INSTR1	0xFF	TIMER5
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x06	STATUS	0xFF	INSTR1	0xFF	TIMER6
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x07	STATUS	0xFF	INSTR1	0xFF	TIMER7
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x08	STATUS	0xFF	INSTR1	0xFF	TIMER8
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x09	STATUS	0xFF	INSTR1	0xFF	TIMER9
0x309	0x1	Node Nr	Group Nr	0xFF	0xFF	0x0A	STATUS	0xFF	INSTR1	0xFF	TIMER10

4.3. Uptime request

Table 4. UPTIME REQUEST (0x113).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x113	0x0	COMP ID1	COMP ID2	0xXX	0xXX	Node Nr	Group Nr	0xXX	0xXX	0xXX	0xXX

0x1130 – UPTIME REQUEST frame

COMP ID1 - computer identifier (must be unique on the network)
COMP ID2 - computer identifier (must be unique on the network)

Node Nr - node number of requested module

Group Nr - group number of requested module

0xXX - inessential data

Table 5. Response to UPTIME REQUEST (0x113).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x113	0x1	Node Nr	Group Nr	0xFF	0xFF	0xFF	0xFF	UPTIME3	UPTIME2	UPTIME1	UPTIME0

0x1131 – Response to UPTIME REQUEST frame

Node Nr - node number on the network
Group Nr - group number of the node on the network

UPTIME - (UPTIME3*256^3+UPTIME2*256^2+UPTIME1*256^1+UPTIME3*256^0) in seconds

4.4. Health check request

Table 6. HEALTH CHECK - STATUS REQUEST (0x115).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x115	0x0	COMP ID1	COMP ID2	0x01	0xXX	Node Nr	Group Nr	0xXX	0xXX	0xXX	0xXX

0x1150 – HEALTH CHECK REQUEST frame

COMP ID1 - computer identifier (must be unique on the network)
COMP ID2 - computer identifier (must be unique on the network)

0x01 - status request

Node Nr - node number of requested module

Group Nr - group number of requested module

0xXX - inessential data

As response the module will send two frames (Table 7).

Table 7. Response to HEALTH CHECK - STATUS REQUEST (0x115).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x115	0x1	Node Nr	Group Nr	0x01	RXCNT	TXCNT	RXCNTMX	TXCNTMX	CANINTCNT	RXERRCNT	TXERRCNT

0x1151 – Response to HEALTH CHECK REQUEST frame

Node Nr - node number on the network
Group Nr - group number of the node on the network

0x01 - frame 1 (current values)

RXCNT - current level of receive FIFO buffer

TXCNT - current level of transmit FIFO buffer

RXCNTMX - maximum level of receive FIFO buffer since power up

TXCNTMX - maximum level of transmit FIFO buffer since power up

CANINTCNT - number of CAN interface restarts since power up

RXERRCNT - current receive errors register

TXERRCNT - current transmit errors register

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x115	0x1	Node Nr	Group Nr	0x02	0xFF	0xFF	RXCNTMXE	TXCNTMXE	CANINTCNTE	RXERRCNTE	TXERRCNTE

0x1151 – Response to HEALTH CHECK REQUEST frame

Node Nr - node number on the network
Group Nr - group number of the node on the network

0x02 - frame 2 (maximum values saved in eeprom memory)

RXCNTMXE - maximum ever level of receive FIFO buffer

TXCNTMXE - maximum ever level of transmit FIFO buffer

CANINTCNTE - maximum ever number of CAN interface restarts

RXERRCNTE - maximum ever receive errors

TXERRCNTE - maximum ever transmit errors

To clear maximum values saved in eeprom memory the frame shown in Table 8 must be sent. There is no response to this message.

Table 8. HEALTH CHECK - CLEAR REQUEST (0x115).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x115	0x0	COMP ID1	COMP ID2	0x02	0xXX	Node Nr	Group Nr	0xXX	0xXX	0xXX	0xXX

0x1150 – HEALTH CHECK REQUEST frame

COMP ID1 - computer identifier (must be unique on the network)
COMP ID2 - computer identifier (must be unique on the network)

0x02 - clear request

Node Nr - node number of requested module

Group Nr - group number of requested module

0xXX - inessential data

5. Module control

The module can be controlled directly from PC, or indirectly by other modules. In both situation all instructions in the table below can be used. Blocking instructions can't be used in direct control.

5.1. Control instruction

The Table 9 shows instructions, which can be executed by the module.

Table 9. Module control instructions

Instruction	Instruction Codding								Note	Control	
	INSTR1	INSTR2	INSTR3	INSTR4	INSTR5	INSTR6	INSTR7	INSTR8		Direct	Indirect
TURN OFF OUTPUT	**0x00**	**CHANNEL 1**	**CHANNEL 2**	**TIMER**	0xXX	0xXX	0xXX	0xXX	It will turn off chosen outputs, and the rest will stay unchanged.	√	√
TURN ON OUTPUT	**0x01**	**CHANNEL 1**	**CHANNEL 2**	**TIMER**	0xXX	0xXX	0xXX	0xXX	It will turn on chosen outputs, and the rest will stay unchanged.		
TOGGLE OUTPUT	**0x02**	**CHANNEL 1**	**CHANNEL 2**	**TIMER**	0xXX	0xXX	0xXX	0xXX	It will toggle chosen outputs, and the rest will stay unchanged.		

0xXX – inessential data

CHANNEL 1	**CHANNEL 2**	Note
0x01	0x00	- <00000001> <00000000> - only output OC1
0x02	0x00	- <00000010> <00000000> - only output OC2
0x03	0x00	- <00000011> <00000000> - output OC1 & OC2
0x04	0x00	- <00000100> <00000000> - only output OC3
...	...	
0xFF	0x03	- <11111111> <00000011> - outputs OC1-OC10

CHANNEL1
bit <0> - output OC1, bit <1> - output OC2, bit <2> - output OC3, bit <3> - output OC4,
bit <4> - output OC5, bit <5> - output OC6, bit <6> - output OC7, bit <7> - output OC8
CHANNEL2
bit <0> - output OC9, bit <1> - output OC10, bit <2> - unused, bit <3> - unused,
bit <4> - unused, bit <5> - unused, bit <6> - unused, bit <7> - unused

TIMER	Note
0x00	- instruction will be executed immediately
0x01	- instruction will be executed with 1s delay
...	
0xFF	- instruction will be executed with 24h delay

ENABLE BOX	**0xDD**	**BoxX**	**BoxY**	0xXX	0xXX	0xXX	0xXX	0xXX	It enables chosen boxes – these boxes will be compared with next received message from the bus.		√
DISABLE BOX	**0xDE**	**BoxX**	**BoxY**	0xXX	0xXX	0xXX	0xXX	0xXX	It disables chosen boxes – these boxes will be passed when next message arrives from the bus.		√
TOGGLE BOX	**0xDF**	**BoxX**	**BoxY**	0xXX	0xXX	0xXX	0xXX	0xXX	It toggles boxes – enables when they are disabled and vice versa		√

0xXX – inessential data

BoxX	Note
0x00	- from Box 1
0x01	- from Box 2
...	
0x7F	- from Box 128

BoxY	Note
0x00	+ 0 -(and not anyone else)
0x01	+ 1 -(and 1 following)
...	
0x7F	+127 -(and 127 following)

5.2. Timer

Each channel has its own timer which can delay execution of the instruction. Delay can be chosen between 1s-24h set in TIMER register. Drawing below shows delay dependence of TIMER register.

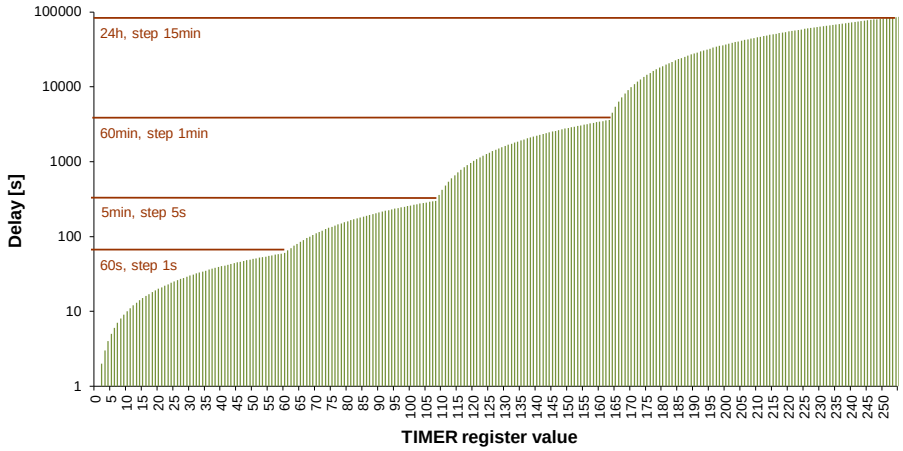


Figure 1. Delay/timer register relationship

5.3. Direct control

It is possible to control module by sending DIRECT CONTROL message. The message contains instruction, which will be executed by the module. The module can be also controlled from HAPCAN Programmer.

Table 10. DIRECT CONTROL frame (0x10A).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x10A	0x0	COMP ID1	COMP ID2	INSTR1	INSTR2	Node Nr	Group Nr	INSTR3	INSTR4	INSTR5	INSTR6

0x10A – DIRECT CONTROL frame

COMP ID1 - computer identifier (must be unique on the network)

COMP ID2 - computer identifier (must be unique on the network)

Node Nr - node number of requested module

Group Nr - group number of requested module

INSTR1-6 - instruction to be executed (byte1)

5.4. Indirect control

Indirect control means that module will react to messages sent by other modules on the network. It depends on configuration programmed into the module boxes (memory cells).
This firmware has feature to set simple conditions of executing instruction. To do so, you can use blocking instruction (0xDD – 0xDF) shown in Table 9.

6. Configuration

Below are parameters that can be configured with this firmware. Configuration process can be done using HAPCAN Programmer.

6.1. Module identifier

Every module on the network must have unique identifier. The identifier is made of two bytes, module number (1 byte) and group number (1 byte). Identifier of the Ethernet Interface can be changed in HAPCAN Programmer in software settings.

6.2. Module description

Every module can have 16 char description, which makes easier for user (programmer) to distinguish nodes.

6.3. Output Names

Each output can be named with 32 chars.

6.4. Power up values

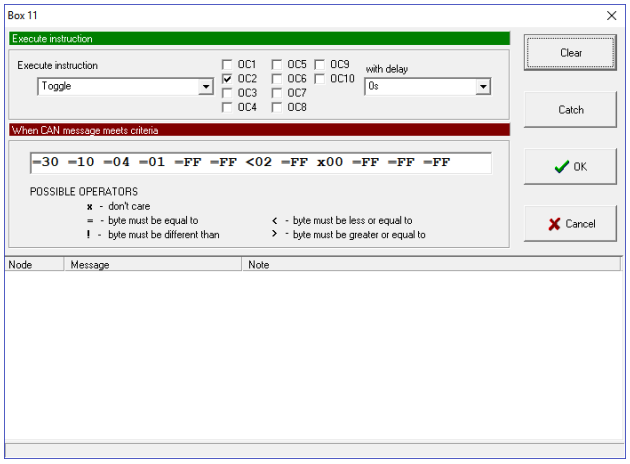
It is possible to configure output states at startup after power loss. At startup the output can be set to ON, OFF or to the last set value. The last set value must be unchanged for at least 6s before power failure. The module sends messages to the bus about the initial state of its outputs.

6.5. Text notes.

Up to 1024 characters can be written into processor's memory.

6.6. Linking devices

The indirect control is used to program the dependencies between modules. It is a controlling the module by messages sent from other modules. Each module when changing its status (eg when button is pressed or released in the button module) sends information that can be used to control the same module, as well as to control other modules located on the bus. For this purpose, the module has 128 boxes (memory cells) into which you can enter messages to which the module is to react when it receives them from the bus. Each box contains information about what message should initiate the action and what instruction should be made when this message is received.



In the figure on a side, the toggle instruction has been programmed, which changes the current state of the OC2 output at the moment of receiving a message from the module button o ID (4.1) - see the description of the BUTTON FRAME in the document "Firmware note" of the button module.

The message bytes are saved in hexadecimal format.

Operators at the front of bytes indicate that the module will react to a message received from the bus in which this byte:
x - can have any value
= - is identical to byte entered here
! - is different than byte entered here
< - is less or equal to byte entered here
> - is greater or equal to byte entered here

In this example:

=30 =10	– button message
=04 =01	– module ID is (4,1)
=FF =FF	– these bytes are not used and in button frame are always 0xFF
<02	– button number is less or equal 2, means button number 1 or 2
=FF	– button is pressed
x00	– it is a byte which gives LED status in the button module. Because we don't want to make instruction execution to be depended on this byte, so this bute can have any value.
=FF =FF =FF	– these bytes are not used and in button frame are always 0xFF

As a result, the module will execute instructions when the module receives a message from the button with ID (4.1), when button number 1 or 2 has been pressed. Instruction is executed regardless of the LED status in the button module.

Each own and received from the bus message informing about the change of module status is checked with each active (enabled) box in the order from box no. 1 to 128. Therefore, you can set the reaction to the same message in two or more boxes. For example, in the first box instruction can be executed without delay, and in the next box another instruction can be executed after the defined time. It is important to keep the logical order of instruction executing to get the desired operation of the module. Calling an instruction that is to be executed without delay will cancel the previously set instruction with a delay.
Boxes can be dynamically activated (enabled) and deactivated (disabled). Blocking instructions are used for this (Table 9). In this way, you can control which boxes are to be checked after receiving the message**.**

7. License

8. Document version

File	Note	Date
univ_3-9-0-0a.pdf	Initial version	March 2018